PATENT SPECIFICATION

988,109

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Inventor: JAMES FRANCIS BLACK.

Date of Application and filing Complete Specification: March 25, 1963.

No. 11712/63

Complete Specification Published: April 7, 1965.

Index at Acceptance:—**A1** X2.

Int. Cl.:—A 01 g.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Use of Asphalt Coatings for Weather Modification

We, ESSO RESEARCH AND ENGINEERING COMPANY, a Corporation duly organised and existing under the laws of the State of Delaware, United States of America, of Elizabeth, New Jersey, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method of causing mass air flow over land areas. It relates particularly to a method for causing a thermal temperature gradient which will cause strong updrafts of air and thereby also induce or initiate lateral air movement on a large scale. The invention is more particularly applicable to situations where it is desired to remove from inhabited areas very large masses of contaminated air, fog, smog, smoke and the like. It has special application to situations where moisture laden air can be moved inland or over arid areas and raised to increase needed precipitation.

One important problem of growing seriousness involves the dense contamination of air over cities situated where atmospheric inversion conditions occur frequently. For example, in some of the Western coastal cities of the United States which lie between the edge of the ocean and elevated land areas, and in other cases where cities are partially enclosed by hills or mountains, atmospheric conditions frequently are such that smoke, fog and other objectionable materials accumulate extensively. These may interfere with visibility and, in some situations, the concentrations become so great as to cause physical discomfort and even interfere with health. Aside from physical comfort and health, visibility may be so seriously reduced that serious traffic hazards on the ground, in the air and in harbors, may be created.

A primary object of the present invention is to induce or initiate large scale or mass air flow across land areas by creating strong updrafts or chimney effects. These effects may readily be produced, for example, along a sloping surface adjoining an area to be cleared of fog or smog. They may also be produced over a relatively flat area of appreciable or substantial expanse.

A separate problem from fog and smog, but one analogous in some respects because it results from lack of air mass movement of proper moisture content and condition, is the lack of moisture in certain areas where otherwise fertile soil becomes useless for agricultural purposes. Many such areas are relatively near oceans or other large bodies of water, but they nevertheless are highly deficient in rainfall. By inducing updrafts which can bring in large masses of moisture laden air from adjoining bodies of water and raise them to heights at which condensation will occur, rainfall and other forms of precipitation may be substantially increased. By this means it becomes possible to rehabilitate or render arable large areas of land which are now relatively worthless. Thus, some of the world's great desert areas may be rendered productive by an increase of precipitation which, in turn, may be caused by increased mass air uplift and lateral flow.

According to the present invention, the foregoing problems, and others which are analogous, may be solved in substantial degree by coating with heat radiating or absorbing materials, selected large and extensive areas of land, e.g., at least three and preferably at least 5 or 10 or more, square miles of land surface. The land surface to be coated may be upsloping such as hillsides and mountain ravines. It may be

[Price 4s. 6d.]

coated continuously or discontinuously with heat radiating and/or heat absorbing materials which are substantially different in heat absorptive and/or heat radiating properties from adjoining areas. In many cases, coatings of black material such as asphalt and related compositions, may be used as these normally absorb and radiate considerably more heat than normal soils and rocks. Asphalt is preferred over most materials for reasons of economy, but other materials can be used. A reverse effect may be created by using white or near white reflective materials such as powdered gypsum, limestone, calcined lime and the like, to coat extensive areas and thereby create relatively cooler areas which may cause downdrafts. These coatings also may be employed in relation to neighboring black coated areas or may be used alone in some cases to augment the lateral flow as well as the downflow of large air masses.

It will be understood that the invention contemplates a strong "triggering" action by the thermal effect of the surface coating. While weather phenomena and mass air flow are but partially understood, the following explanation will help in understanding the invention. Air cools as it rises, the rate of cooling being in the general range of about 1°C. per 100 meters rise. Clouds form as the water vapor in the air condenses when the ascending air reaches its dewpoint. This condensation is accompanied by strong release of energy (latent heat of evaporation), which causes the air to rise even more vigorously and may cause strong updrafts carrying the resulting cloud top to high altitudes. In summer time the "thunderheads" which commonly presage violent rainstorms are commonly understood to be produced by such mechanism. By starting an updraft, due to heating air near the ground by radiation and conduction from an extensive black surface, the air may be pushed vigorously up to where condensation starts to form clouds. The energy released by the condensation itself then pushes the cloud more rapidly to greater heights.

The sea breeze, which commonly blows on summer days, is an example of an atmospheric motion produced by convective heating. If a large area near the shore is coated with asphalt, it will produce increased convective heating and strengthen the intensity of the sea breeze. This increase in the period of time over which the sea breeze is established and in its maximum intensity, can be used to clear smog or fog from otherwise relatively stagnant areas. It should be emphasized that extensive areas such as ten square miles, and up to 100 square miles or more of coated area appear to be required for really large scale effects.

The invention will be more fully understood by referring to the accompanying drawings, wherein:

Fig. 1 illustrates a situation where air mass flow and the large updrafts or chimney effects may be caused by coating a sloping hillside with a heat radiating material;

Fig. 2 is a plan view of a typical situation around a city where a strong chimney effect can beneficially be used to clear fog, smog, smoke and the like from a relatively flat area partly surrounded by hills;

Fig. 3 represents in profile another situation similar to Fig. 1 wherein the mass air lateral flow caused by coating a hillside with heat-radiating material to create a daytime updraft is further augmented by coating a further surface with heat reflective and relatively non-radiating material to cause a downdraft of air;

Fig. 4 is a profile view of a situation where, by application of heat absorbing and radiating material of different reflective and radiating properties from the general land area, air mass may be moved upwardly and landward from an adjacent body of water; and

Fig. 5 shows in profile an application to hilly areas adjacent to a body of water to move inland a mass of moisture laden air for precipitation over an area deficient in rainfall.

Referring in more detail to the drawings, in Fig. 1 a body of water such as a seaside 11 adjoins a relatively flat area 13 which may be the location of a town or city. A hill, range or row of hills or mountains 15 lies behind the city. Atmospheric inversion conditions frequently occur along the dotted line 17, causing relative air stagnation with resultant accumulation of smoke and fog to the detriment of the city area. By coating one or more large areas of the hillside with a black heat radiating material 19, one or more updrafts or chimney effects in the atmosphere may be created, as indicated by the arrows 21. These updrafts or chimney effects lift the lower air to greater elevations, enhancing lateral flow from the left. As a result, fresh air from the sea or other body of water flows landward. In addition to sweeping smog and fog away, increased precipitation over and beyond the hills frequently will be caused. The fresh air promptly breaks through the inversion layer and causes the fog and smoke to dissipate upwardly and to the right.

In Fig. 2 several hillside areas 19', 20', 21', large enough to be capable of producing very substantial updrafts, are shown, wherein a heat absorbing coating material, preferably asphalt or a residual petroleum product, is applied to selected areas. Other black materials, or near black, may be used when economically feasible. These coated areas may be barren hillsides, or they may

comprise ravines leading up into the hills or into areas particularly located to absorb heat from the sun. Even where the town or city itself receives relatively little sunshine, e.g., due to overlying fog or smog, etc., the hillsides, which usually are largely or at least partly above the darkening fog will normally receive ample sunshine. By proper study of topography and relative normal impact of sunshine, as well as atmospheric and prevailing wind conditions, optimum areas of sufficiently large extent are selected for coating so as to cause substantial air movement even in absence of wind. For a large city, the coated areas will need to be at least a mile in extent in either direction, and preferably several miles. The area required will vary somewhat with character of the earth and the hillsides. For a city occupying 250 square miles, at least 25 square miles should be coated, and preferably 40 or more. The coating need not necessarily be continuous but it must be one which will substantially enhance the "thermal mountain" effect, i.e., the production of a high updraft analogous to the lift of a substantial breeze or wind going over a mountain.

Referring to Fig. 3, the general situation is substantially the same as in Fig. 1. A body of water 31 adjoins a relatively low land area 33 on which there may be a city or other area to be cleared of atmospheric pollution. Alternatively, in case it is desired to increase precipitation over hill 34, the same principle applies. By coating the hillside 35, or suitable large and extensive parts of it, with minimum dimensions of three square miles, with a layer of highly radiating material such as asphalt or equivalent 39, an updraft or chimney effect may be created as indicated by the arrows 41. This causes a very substantial mass air flow landward and over the hill, with fresh clean air breaking through and disrupting the inversion layer. To further accelerate or augment the air mass flow, a coating of relatively white reflective and relatively low-radiating material 43 is applied to the opposite slope of the hill or rang 35 to cause a downdraft on the other side. This downdraft is due to the fact that the white (or near white) coated area reflects more solar radiation than adjoining areas, i.e., it absorbs less, and is therefore substantially cooler.

Referring now to Fig. 4, a situation is shown which applies to land areas having no substantial hills near a sea coast 50. An area 52 may be coated near the water 51 to cause updrafts 53 with cloud formation 54. The normal sea breezes 55 moves the clouds landward and condensation causes rain to fall over area 56. Cool air mass 57 from inland is drawn towards the base of the rising cloud and assists in causing precipitation.

As previously noted, the materials presently preferred for the heat absorbing and radiating coating are the heavy residual petroleum oils and asphalt. Asphalt and related normally solid or plastic materials derived from petroleum residues are relatively inexpensive and are especially preferred. Among the various forms of asphalt, the aqueous emulsions, either acidic or alkaline, are presently preferred for reasons of economy and ease of application. Cut-backs may be used, or emulsified cut-backs. For example, a square mile of surface may be coated with a thin layer of emulsion for a cost under $20,000. By application of sufficiently large areas of a highly heat absorbent and radiative coating to sites which are properly selected, very substantial rising air currents may be created during daylight hours.

In the case of Fig. 4, for example, the coated area should extend for at least one and preferably three or more miles in depth and at least one mile along the coast. It should be within five or ten miles of the coast if possible. Resulting updrafts 53 are then on a sufficiently large scale to cause incipient condensation and formation of rain clouds 54. These clouds are swept inland by the normal landward breezes 55, causing rainfall over area 56.

At certain times, as at night, the land cools more rapidly than the water and land breezes spring up. The warmer water, under favorable conditions, causes updrafts which move inland to meet the cool air masses 57. Under these conditions, the breezes and clouds are effective to increase precipitation. By calculations based on known data of temperature, moisture content of air, and heat effects, it can be shown that precipitation over an area such as 56 can be increased by as much as 20 inches per year, and the increased precipitation can be extended over an area up to three times as large as, or larger than, the coated area 52.

By coating suitably extensive areas of hillsides to create major updrafts or chimney effects, substantial masses of moisture laden air may be moved inland at relatively small expense compared with the benefits. Hills or upsloping areas are advantageous but even where there are not substantial hills nearby, large mass air movements can be produced by coating suitable areas, provided that landward breezes are available to move moisture laden air overlying a body of water towards the area to be coated. An example of an application to an upland area near a body of water is shown in Fig. 5.

A rainfall deficient area 60, Fig. 5, is shown within reasonable distance of a large body of water 61, and may be made arable by coating a substantial area 62 near or with-

in a few miles from the water's edge with a strongly heat radiating material such as an asphalt emulsion. An updraft 63 from the coated area initiates a strong thermal upflow 64, and draws in warm moist air 65 from the water area. As it rises it condenses to clouds 67. These meanwhile are normally moving inland and rain falls inland from the coated area. In addition, at certain times a mass of cool dry air 68 may move in from the opposite landward area, e.g., at night. The cool air helps further to precipitate moisture 66 along the landward border of the coated strip. This may be farther inland than the coated area, or may overlap in part the coated strip 62, depending on the area coated and the velocity of the air currents and their direction, etc. It is estimated that a strip of land 20 miles wide or more may be successfully watered in this manner by coating a strip five to ten miles wide. As vegetation increases over the years following increased rainfall, the prevailing temperature, humidity and air current conditions will also improve to some degree under favourable conditions of sunlight in daytime and night radiation from the earth. This has been experienced in large irrigated areas in Western United States. Hence, in time, considerable larger areas may be rendered arable and/or habitable by relatively modest expenditures of coating materials. The coating material will gradually disintegrate but a good coating properly applied will last several years on many soils, in some cases as long as ten years or more. In particular, with stable soil or rock surface conditions, where wind and water do not cause much erosion or soil movement, a single thin application of such a coating as acidic or basic emulsion of asphalt may last for quite a number of years before requiring renewals, so far as its effects on air currents are concerned.

The lifetime and effectiveness of the coating, particularly when it involves asphalt or residual petroleum materials, may be substantially increased by incorporating therein materials which prevent deterioration, or which inhibit or destroy the causes of deteroration. Thus herbicides may be incorporated in the coating itself to prevent growth of vegetation through the coating. In general, materials inimical to all organic life are contemplated. In some cases coating materials such as certain types of asphalt material are subject to extensive attack by animal life. Biological poisons or repellents may be added under suitable circumstances to prevent or reduce attack by insects, including those in the larva state and, in fact, may be extended to prevent attack by larger animate life such as birds and animals.

In some circumstances it may be desirable to fence in the area which is coated to keep out animals, or to reduce or restrict the movement of drifting sand and other material which might obscure or obliterate the coating. An analogous effect can be achieved by establishing a poison or inhibitor zone around the margin of a coated area, for example, to minimize or prevent encroachment of animal or vegetable life into such area.

In lieu of actual poisons, which might be unduly destructive of certain types of wild life, there are available various repellent materials which may be employed to discourage animal or insect attack.

Where possible, the dark colored coating material will be applied to the higher ground, preferably above the inversion level, where an inversion is involved.

In the prior art a technique is well known for precipitating moisture from clouds by "cloud seeding." The present invention contemplates, in addition to the coating of large ground areas with black or relatively black material to produce strong thermal updrafts and facilitate cloud formation, the use of the cloud seeding technique as an auxiliary measure when such appears desirable. Finely divided particles to be employed for cloud seeding may actually be distributed high in the air prior to actual cloud formation, if desired, so that as they slowly descend and disperse, they may reach the cloud and begin their effect when the cloud is in approximately the desired position to produce rainfall. The present invention gives a much better control over the placing of rainfall than simple cloud seeding per se, even when the latter is effective. By coordinating the timing of the cloud seeding with respect to the updraft produced from the black surface and the lateral air mass travel due to wind or due to a combination of wind and updraft, moisture may be precipitated in substantial quantities and in approximately the areas most desired.

The cloud seeding materials and procedures are known in the art and comprise such materials as finely divided silver iodide, solid carbon dioxide, carbon black, ice crystals and other solid substances capable of promoting condensation of the cloud moisture into raindrops. By the technique just described, rain sometimes may be produced in a cloud which otherwise would not quite reach the ponit of incipient precipitation. Obviously, the employment of a cloud seeding procedure is useless if there are no clouds or if there is insufficient moisture in the atmosphere to produce precipitation. The method of causing large updrafts to cause cloud formation, as described above, greatly enhances the possibility of producing controlled precipitation. The combination of these two techniques gives a flexibility and opportunity for large scale weather control

not previously available.

Obviously, some of the areas within suitable distance of the lands to be watered may be coated with relatively white or non-radiating materials such as lime or gypsum, as described above, to augment or modify the air mass effects. However, the strong updrafts arising from strongly radiating areas are normally sufficiently effective and these are ordinarily the predominating factor.

In the claims which follow, it will be understood that reference to significant weather changes means effects such as winds and updrafts which are substantial enough in mass, extent, and velocity to remove smog from cities, or to cause significant increases or rainfall or other precipitation over an area at least as large as the coated area, and to produce analogous effects of comparable magnitude. A minimum minor dimension of a coated area is apparently at least one mile, with a larger major dimension. The object of this invention cannot be achieved with the coating or relatively small areas. Preferably, for significant effects over large cities or large arid areas, an area of ten square miles, in one body, or in several (at least a square mile and preferably more in each) should be coated.

The foregoing and other applications of the principles discussed can be modified, extended or amplified, as will be obvious to those skilled in the art. They can also be combined with other known techniques.

WHAT WE CLAIM IS:—

1. A method of iniating mass air flow over land areas sufficient to initiate significant weather changes which comprises applying to an area of land of at least three square miles in extent, a coating of material which has substantially different heat reflective and/or radiation properties from the surrounding areas, said coating being effective to produce a large scale thermal draft.

2. The method as claimed in claim 1 of causing substantial air currents to move laterally across adjacent areas, wherein the smallest lateral dimension of the area to which the said coating is applied is at least one mile.

3. The method as claimed in claim 1 or claim 2 of causing a large mass of relatively still air to move, to cause significant weather changes over a land area which adjoins a sloping higher area, which comprises applying said coating material to a selected portion of said sloping area.

4. Method according to Claim 1 wherein the coating material comprises asphalt.

5. Method according to Claim 2 wherein the coating material comprises asphalt.

6. Method according to Claim 3 wherein the coating material comprises asphalt.

7. Method according to Claim 1 wherein the coating material is primarily an aqueous asphalt emulsion.

8. Method according to Claim 2 wherein the coating material is primarily an aqueous asphalt emulsion.

9. Method according to Claim 3 wherein the coating material is primarily an aqueous asphalt emulsion.

10. Method according to Claim 3 wherein a downslope area beyond and in continuation of the sloping higher area is also coated at least in part with a composition having substantially lower heat radiating capacity than the surrounding area, to produce a cooling downflow effect and thereby augment the lateral flow caused by said chimney effect.

11. The method of clearing smog and other objectionable atmospheric pollution from an urban area partly surrounded by hills, which comprises applying to a total of at least ten square miles of area on a selected portion or portions of hillsides coating materials of high heat absorptive and heat radiating capacity, so as to create a large scale chimney effect and cause air mass to flow away from said urban area.

12. The method of causing large air mass movements to increase precipitation over an arid land area, which comprises coating an area of land at least a mile in depth and of a total area of at least three square miles, with a highly heat radiative material to cause an updraft in locations such as to draw large masses of relatively humid air over said arid area.

13. Method according to Claim 12 wherein mass airflow effects are augmented by coating supplemental land areas with relatively non-radiating materials.

14. A method of causing large air mass movements which comprises coating an area of land at least a mile in one direction and of at least three square miles in total area, with a residual petroleum product of high heat absorbing and radiating character, and said residual petroleum product including a substance to inhibit deterioration by organic life.

15. Method according to Claim 14 wherein a herbicide is incorporated in the petroleum product.

16. Method according to Claim 14 wherein a material repellent to animal life is incorporated in said petroleum product.

K. J. VERYARD,
50, Stratton Street, W.14.
Agents for the Applicants.

Berwick-upon-Tweed: Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd.—1965
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2 from which copies may be obtained.

988109 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG.1.

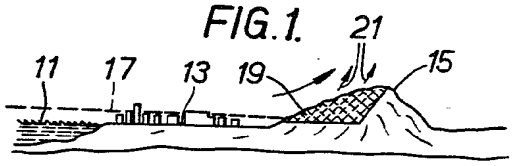

FIG.2.

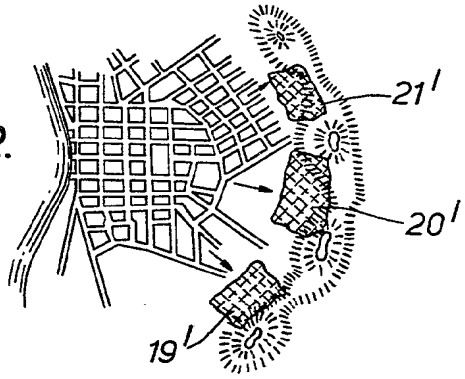

FIG.3.

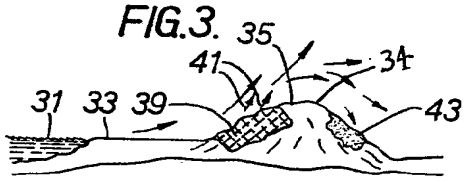

FIG.4.

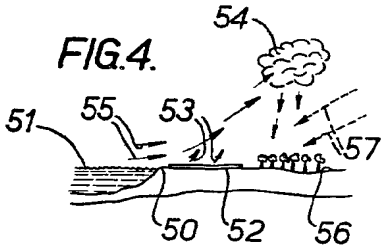

FIG.5.